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REVIEW ON RESCUE AND PROTECTION SYSTEM FOR UNDERGROUND MINE WORKERS AND FACTORY WORKERS

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Abstract: *On the basis of this study ideas were explored, some of the different devices, techniques and aspects that influenced the formation of different rescue and protection systems. The research in various dimensions on the topic helped in enhancement of the knowledge in this field of technology. Analysis of each and every side of this project was done. The motive also constituted of expanding the applications of the project. In the past times, the rescue and protection systems which were constructed were bulky and slow. Here in this project, the aim is to reduce the size and increase its time efficiency using the ZigBee technology. There have been instances in the news over the past few years in which we have seen lack of responsibility for the people working in life threatening situations which even led to disasters some of the times. After examining different areas of the same we have come on the terms of agreement with the fact that this problem requires a lot of concern. Taking up the responsibility to eradicate such issues we finally decided to come up with the solution removing all the problems.*

Keywords - ZigBee, Sensors, Arduino, Protection System, micro-controller

1. Introduction

Monitoring environmental conditions and proper communication has always been an important task to make sure safe working conditions and increase productivity in underground coal mines. The gassy underground atmosphere is hazardous which will stumble upon various factors because of which dangerous incidents like explosion may happen [13]. Current communication and monitoring systems in underground mines are cable based or in nature. Cable-based communication and monitoring has limitations like: liable to failure during any form of breakage in cable at the time of disaster; any possibility of sparks or flames thanks to any wrong design; or communication only from point to point is out there, can't be established from anywhere in an underground mine, inability to speak with moveable men; with the working surface expanded, a blind area for monitoring appears, then the new installation and maintenance is required. Therefore, the event of cost-effective, reliable, maintenance- free, continuous monitoring, and safety solution for underground mine workers could be a burning need today. There's a necessity to develop a wireless network system to quickly detect and determine the environment conditions and accurately provide location references to evacuate workers from the harmful zone. But, the underground coal mines possess variety of inherent challenges [23, 24]. Though, most of the researches in wireless monitoring systems have focused on the look of hardware and software within the sensor units and wireless communication capability of radio modules, these kinds of work face more difficult environments, where the system is predicted to figure against larger structure variations possibly caused by collapses or explosions. Wireless monitoring system is additionally expected to be more flexible and easier to be deployed and removed, because the progress of coal pit digging requires frequent movement of the system. Although many protocols and algorithms are proposed for traditional wireless spontaneous networks, they're not similar temperament for the unique features and application requirements of underground sensor networks. The challenge isn't only to seek out an honest topology for wireless devices, but a mix of techniques which will be efficient for location in coal pit galleries. the info for the placement of workers and also the mobile equipment is required to be taken from each section of mine corridor [50].

2.Zigbee technology

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Research on ZigBee wireless communication technology and its application: Due to the increasing demand of wireless communication at different stages in life, wireless sensor network technology has a better working system. ZigBee protocol standard technology is better than many emerging wireless sensor network technologies due to its unique short distance and excellent characteristics. This technology promotes the development of wireless personal area network, and also plays an increasingly important role in people's life. Based on the principles and characteristics of ZigBee wireless communication technology, this paper focuses on its protocol framework, and analyses and looks forward to its application prospect in People's Daily life. This technology just focuses on shorter radius and is not helpful in long distance communications which can be worked upon making this project of wide usage [1,4]. ZigBee and Wi-Fi based Safety System for Mine Workers: This paper focuses on a cost- efficient, flexible solution for underground mine workers' safety. A system of sensors and webcam is used for underground environment monitoring and analyzing measurement data through digital wireless communication technique is proposed with high accuracy, smooth control and reliability [4,19,47]. A microcontroller is used here for gathering all the data and information and making decision, based on which the mine worker is informed through alarm as well as voice system. Also, the wireless camera is used for visual distant monitoring purpose. This project is very specific in nature and can only be used in mines and factories. If some brainstorming is done its area of usage can be expanded. A Review Paper on ZigBee (IEEE 802.15.4) Standard: The research paper explained how ZigBee has made it easier to install a wireless network [10]. As, mentioned in the paper wireless sensor networks has always been easy to install than the wired sensor networks as they cost more than the wireless networks but wireless systems consumed much power so the ZigBee was introduced as a standard by the IEEE 802.15,4 as a simple, low power sensor node which is used for small distance transmission and works more efficiently without sacrificing the reliability of the network [2]. This paper also proposes many topologies in which the nodes can be placed in the network and to find which works the best. It also mentioned that as there are many areas of application for ZigBee there will be further research on the same. The wireless communication is expanding and so in the coming future there will be more need to focus in this area. There are so many different topologies to implement and to find the best implementation of every topology needs to be done which can take a lot of time [3]. Integrated Mine Safety Monitoring and Alerting System Using ZigBee & Can Bus: As the recent research shows the paper mentions that the disasters in the coal mines are increased in the last few years and there is still a lot of work that needs to be done in this field to ensure the safety of the coal mine workers. Also, the wired system cost much more and consumes time in the installation as well. The proposed work in the research paper discusses how with the help of CAN bus along with ZigBee the cost can be reduced and the speed of communication between the ground station and underground network is improved. The implementation of integrated mine Safety monitor system is explained in the paper [2,4]. It can also alarm automatically when environment parameters are abnormal, which help improve the level of monitoring and safety to reduce accident in the coal mine. It really doesn't explain that how the CAN bus can improve the characteristics in the [5,38] As wireless sensor technology is improving; hence increasing number of organizations are using it. ZigBee technology is a new standard in wireless personal garret after Bluetooth. After an introduction to this technology, a new wireless meter-reading system based on ZigBee protocol has evolved. This system, which consists of ZigBee network and database management system, has a lot of important advantages such as low cost, and low date rate. Fusion of RFID and ZigBee is possible which turn out to be very helpful for wireless sensor network technology. A complete overview of wireless sensor network technology is given in the paper. Wireless sensor network technology has become one of the basic needs of us. [6,50] Automatic Monitoring System in Underground Engineering Construction: Review and Prospect. Automated monitoring systems are one of the main means to ensure the safety in the underground working environments. This paper gives an idea of current international research and application status of the underground engineering monitoring system from three aspects i.e., data acquisition, data transmission, and data processing .Furthermore, this paper gives specific and implementable technical routes based on the current intelligent technology and the challenges faced by future monitoring, which can provide direction and reference for future research, including high-precision real- time acquisition and safe and reliable transmission of monitoring data, multisource data fusion, and the visual intelligent early warning platform. If the automatic system fails or gets corrupted then what other ways are needed to ensure the safety is not included in this paper.

3. WSN Technology

A Wireless Safety System for Underground Mine Workers Based on WSN: A cost-effective and flexible solution as a replacement of traditional wired security system is explained in this research paper. A series of sensors are used during the implementation so that it can work with high accuracy and smooth control for the base as well as the workers. The series of sensors detects the parameters like temperature, vibrations, gas, etc. continuously for better performance and if the parameter may vary than the defined limits it can alert the base unit and the mine workers through the alarm [7]. The base units get the detected signal and monitor them. This is how the project will work and to ensure more safety, an effective wireless ZigBee system is installed based on IEEE 802.15.4 standard, [8,11] also continuous conversation is possible between the workers and the base unit. The whole process seems too costly and if we are talking about placing every module at a certain amount of distance it can also take a lot of time. Rescue and Protection System for Coal Mine Workers by Using WSN: In the given research paper, a wireless coal mining safety system is introduced using a ZigBee. It will replace the old wired security system as they are more complicated to handle and also does not works very efficiently with today’s fast-growing technology. With the help of WSN the cables can be easily substituted and the construction cost of the security can also be reduced. In the paper it is mentioned that there are two sections in the project, the first section is underground section and the other section is ground section. In the first section, there are many sensors that are the part of the security system and continuously monitor the changes at different parameter. This information is received by the ground section, so that a proper communication can be maintained. This research paper gives the whole layout and plan of the proposed work. It doesn’t give the possibility of the communication between the underground workers to the ground worker which must be necessary in the security system.

4. Sensor Technology

Humidity Sensors for High Energy Physics Applications- A Review: In the world today the humidity sensors for high energy detection damages very quickly and hence gives a low performance as expected. This paper helped in thorough study of all humidity sensors and their working principles; it also discusses the challenges that can occur while building a high- energy detector [7,9]. The humidity sensors face high radiations at the sub-zero temperatures which is not good as a working condition for the detectors. As the usage of the detectors is increasing it has become more important to keep the performance of silicon- based detectors in control, so they do not get damaged quickly and give better performance in the required areas. The research on humidity detectors is still going on and to improve their working as well. It does not specify how humidity sensor can work for low energy detection which can be a drawback in the system.

Test system for gas sensors: Testing of instruments such as sensors and systems is very important. This particular research paper focuses on the working of gas sensors. The test system of the Fraunhofer-Institute for Solid State Technology (IFT) provides independent mixing of two test gases together with humidification at a high dynamic range. An idea about the calculations required for the volumetric mixing of gases is provided. Two test chambers were developed, tested for a small volume of gases and a precisely defined gas stream. These test chambers simultaneously contain up to ten sensors of different types and provide measurements of gas temperature and pressure. The exhaust gases are analysed by a dew-point mirror and an optional infrared gas analyser to check the gas combination and accuracy of gas concentration. Measurements of the sensors, dielectric sensors determine the quality and flexibility of the test system. If testing of specific gas sensor individually and its analyses it would have given a better idea about them. Working Principle of Arduino And Using It as a Tool for Study and Research: The working and principles on which the Arduino board is based is described in this research paper along with all the research and study works. With this paper it is explained how Arduino boards are used as an efficient tool in the development of VLSI test bench. Arduino as explained in this paper is an open-source microcontroller on which the programming and reprogramming can be easily done and very quickly. It is also mentioned how Arduino has marked its place in our day to day lives, as the technology is increasing daily, we need a device which can works faster and can be easily installed. Arduino has all these qualities and can be easily use to implement and innovate new things. The paper is more focused on the needs of Arduino board rather than the areas of application and the specifications of the Arduino board.

5. Hazards To Be Cured

A variety of potential hazards are present in the underground mining which include- fire, explosion, inundation, roof collapse, toxic gases, chemical pollution, etc [21]. Over past centuries, in US alone, more than 1, 00,000 miners lost their life in accidents which occurred in factories and mines. The existing safety methods used in underground mines concentrate on the monitoring of the hazardous gases, fire detection and ventilation. Advanced instruments and monitoring techniques have significantly reduced the accidents in the mines. However, despite the advancement of these monitoring facilities, accidents still occur in underground mining annually in the world, and many miners are killed because they are trapped and are unable to escape due to blocked exit. A new emergency evacuation system in underground mines is described and analysed the advantages and disadvantages of the system. It is expected that the new system will greatly improve the emergency exit methods and save more lives in the future [10]. Coal mining plays a vital role in most of the developing countries to meet the energy demands. But at the same time mining industry is facing many problems which mainly consist of the mine worker’s safety. Especially the underground mine environment is very complex. The emissions of toxic gases like methane and carbon are there in coal mine. The concentration of these gases above safety threshold level creates risk of mine worker’s health and life. Hence a continuous monitoring of such parameters is necessary. The paper proposes a mine safety monitoring system based on ARM7 and ZigBee for safety purposes. The system takes into account different environmental parameters from underground mine with the help of sensor node structure and transmits that data for processing. If the environment is so harsh beyond the working conditions, the alert messages can be sent to take control measures and keep safety standards. The system achieves many advantages for monitoring, controlling mine production, safety management along with low power consumption platform. The main objective of the paper is to develop an embedded system to monitor the harmful emissions like CO2, LPG in coal mines and it is also used to control the temperature and humidity. Coal mine emission parameters like CO2, LPG etc can be continuously monitored by using Gas sensor, temperature monitored by temperature sensor, and humidity being monitored by humidity sensor respectively. The hardware is placed inside the coal mines. Whenever any poison gases, fire are detected by the sensors connected to the micro controller, and buzzer will beep & transmits the data through ZigBee. The transmitted data will be received by the ZigBee receiver and this information will be passed to the higher authorities and emergency services by using GSM module. Based on continuous revolution of coal mining technology, this paper gives a project about safety monitoring system of coal mine using ZigBee technology and RS485 interface. A system that is designed using group of sensors which monitors the different environmental condition in underground mines and if value exceeds from threshold value, then the Miners are informed through Alarm. Another technique is wireless sensor network software, which is developed to trace underground miners by sending the alert message to control stations. The paper shows that the system is flexible in the architecture of software and hardware, and can easily be extended to other mine safety fields. The single most valuable asset in any organization is its human resources. The ingenuity of employees leads to effective and efficient utilization of all other resources and to achieve economic and social goals of the organization. Protection of employees from hazards in the occupational environment is important from the humanitarian point of view and for the welfare of the organization. It is essential for sound management, for the health and safety of the miners, and for the survival of the organization in a competitive world. A quoted saying states: “The safest mine is the most profitable mine.” The betterment of mining workplace health and safety requires the recognition that mining remains hazardous and that is cautious in addressing the hazards can never be neglected. Miners health and safety are major concerns for mine managements, labor organizations, and the government. This concern has manifested itself in four control mechanisms: regulatory control through the passage of laws and regulations; legal and social control through compensation laws for occupation-related injuries and health deterioration; medical control through periodic examinations; and engineering control through the design and operation of mines according to the best recommended practices. An important aspect of all the approaches is the search for new tools and techniques that will further improves the controlling of these hazards. To create safe mining environments, improved tools, technologies, and techniques must be successfully integrated and applied in the organization. Smart sensor elements are equipped with built-in electronics, so that they can interact with other devices to process the data received. For these sensors the technologies for producing and using the sensors and the electronic components should be congruent. This consistency should be required not only in the production phase but also for problems that can occur during the lifetime of the application. This requirement conflict is clearly visible: On the one hand, sensor elements should interact with the physical environment as evenly as possible, whereas the electronic circuitry should be protected from dangerous environments to protect it from damage and corrosion. Yet for some sensors this problem does not exists. For instance, in smart temperature sensors it is possible to assemble the sensor chips in closed packages, whereas the physical quantities, being temperature and humidity, can still be calculated because with proper care the values of the mentioned quantities are equal inside and outside of the package.

6. Existing Protection Systems

A Smart Women protection system using Internet of Things and Open-Source Technology: Over the period of time women are going through variety of assaults and attacks like rapes, acid attacks, etc. Since a long time, researchers are working on an efficient women protection system which protects women. In this paper, a convincing protection and alert framework for women has been evolved. The refined system assures a safeguard for women in the aspects of tracking, recording and self- defence. The smart women protection system is unified with Internet of things and open-source technology to contribute favoured ensue. The Raspberry Pi 3 and ESP8266 Wi-Fi device employed with modules aforementioned as fingerprint, GSM, GPS, camera, body sensors and Nerve simulator to safeguard the women. The GSM, GPS, camera, fingerprint module and body sensors ensures the tracking and location of the women. The nerve simulator employs the job of self-defense. In troublesome situation, women in the equipped device ensures the fingerprint and then the GPS and GSM equipped with a microphone and speaker, camera and body sensors will be triggered and the location alerts will be directed to the corresponding people and stats will be updated in the server also with the aid of nerve simulator an array of shocks can be remitted to the attacker. The developed framework ensures that it immensely accomplish its task of protecting a woman in all the dangerous circumstances. In the rapidly growing IoT applications from electronics to industrial mechanical equipments and sensors are getting wirelessly connected to the internet. Many well-known communication technologies such as Wi-Fi, ZigBee, Bluetooth and cellular are used for transfer data in IoT. [19,33]. The choice of corresponding technology or combination of technologies depends on application or other factors such as data requirements, communication range, security and power demands, battery life. In this paper the focus is on ZigBee wireless technology and testing ZigBee developed devices in order to see how transmission range impacts on quality of parameters. One of the major hazards in an underground coal mine is the interaction between mining equipment and miners. This is the result of less sight around underground equipment and the closet space within which the equipment is operated [5]. In the view of this hazard, various proximity detection systems were developed. In addition, the detection zones of the different proximity detection systems, were analysed on surface as well as underground. The underground zones were determined under “natural conditions” (reference pattern), in the locally underground substation, marking at different heights, and multiple marks in zones. This results in a documented comparison of the proximity detection systems performance when exposed to the same scenario. This will allow a mine management to make an well-thought selection of the most suitable detection system. The detection results provide a comparison between the performance of a detection system on surface and underground [41]. The results also present the comparison for “natural conditions” of the proximity detection system and when subjected to EMF radiation, multiple marks and marks at different heights.

7.Technological Advancements In The Systems

In the paper there's a mining monitoring system using Wi-Fi. This method defines the security of employee working in mining area under stimulated conditions. In any mining, establishment of strong and continuous communication between workers and sever is important to alert them during unpredictable condition. There are many parameters like water level , emission of poisonous gases, vibration like cracks of earth core, changes in temperature, humidity changes, noise and dirt, air-flow should be monitored continuously for the protection of the life working inside mining area. The explosive development of computer technologies makes it possible to predict a rise within the number of products and objects that interact and are controlled via the web. Enrichment of the relations within the human society, and between the society and also the environment creates a basis for transition to a replacement stage of technology development, which is characterized by the concept of the "Internet of Things." The term "thing" is interpreted here within the broadest sense of the word. It is often an object (e.g., some reasonably manufacturing) or product. It will be animate or inanimate but should be connected with the digital world through communications and identified in time and space. Important components of the web of Things are the so- called "cyber-physical systems" (CPS) within which various objects are combined by multichannel measurement systems with built-in software. This paper addresses the recent technological comprehensive developments within the area of communication and environment monitoring in underground mines. It points out the suitability of application of recently developed wireless sensor network (WSN) for this purpose as proposed by different researcher everywhere the globe. the likelihood of image, video surveillance and use of robot are explored here. Need of real-time implementation of proper system inside regulated hazardous mining environment is evaluated in details. within the present scenario major mine disaster takes place through explosion and fire. The proposed system comprises of a Compressed fossil fuel (CNG) sensor, a driver circuit & a Blower connected to the LabVIEW where the concentration of methane gas present in underground mine may be monitored, controlled and also the signal is generated by LabVIEW [24]. When the methane gas concentration reaches (5-15%), the Blower pumps the atmospheric air into the underground coalpit field, so as to dilute the methane gas. just in case of Blower failure, a proximity sensor which is present at the Blower detects & indicates the fault to LabVIEW. LabVIEW is programmed in such the simplest way that automatic switching is created to a standby Blower and therefore the information is shipped to the mechanical and electrical department by means of audio information. just in case of unpredictable failure within the Blower the knowledge is additionally sent to the rescue team so as to alert them, meanwhile when the methane concentration reaches a selected level the alert rescue signal is shipped to rescue team, to safeguard the miners. because the explosion takes place because of increase in methane concentration during this critical situation, the emergency signal is distributed to the hearth and department of local government through GSM network using LabVIEW. but these safety measures, just in case of any personal pathological state for the miners working underground, a health trigger is provided inside the mine, when the trigger is pressed just in case of emergency condition the knowledge is distributed to the primary aid and rescue team via LabVIEW to the speakers to form applications for smart environments we are able to select from a large type of sensors that measure environmental parameters or detect activities of various actors within the premises. Capacitive proximity sensors use weak electric fields to acknowledge conductive objects, like the anatomy. they'll be unobtrusively applied or perhaps provide information when hidden from view. within the past .years various research groups have used this sensor category to make singular applications during this domain. On the subsequent pages we discuss the appliance of capacitive proximity sensors in smart environments, establishing a classification compared to other sensor technologies. We provides a detailed overview of the background of this sensing technology and identify specific application domains. supported existing systems from literature and variety of prototypes we've created within the past years we will specify benefits and limitations of this technology and provides a collection of guidelines to researchers that are considering this technology in their smart environment applications. In our Country, although it's super power and an economic development, but still there are many crimes against women. The atrocities against the ladies is delivered to an end with the assistance of our product “FEMME”. This device may be a security system, specially designed for ladies in distress. Method/Analysis: Using ARM controller for the hardware device is that the best and it consumes less power. We use frequency signal detector to detect hidden cameras. Findings: We analysed that there's no security device for our total safety [22,35]. The user should carry multiple devices. We found an ALL-IN-ONE security device which has all the features in one click. Applications/Improvements: during this paper we used ARM controller and android application within which both the device and therefore the smart phone are synchronized using Bluetooth, hence both are often triggered independently. we will record audio for further investigation and may give an alert call and message to the pre-set contacts with the moment location every 2 minutes and may be tracked live using our application. Hidden camera detector is additionally a definite feature using which we will ensure our privacy. There are numerous imperative digital text-based proofs, a number of which are SMS (Short Message Services), messages, mails, chat logs, etc. The one who researches a case is fundamentally overflowed with information and he has to invest all his profitable examination time, examining through the loud indexed lists and experiencing unimportant query items. Hence a system is initiated using digital textual data processing standards for configuration and execution, which boosts IIR (Intelligent Information Retrieval) viability in digital forensics. The framework analyzes the input corpus data with domain specific keywords after which search and ranking of the SMSs, supported the load of the keywords of forensic interest is computed. This software is developed as a signal of concept with data processing and weighted search concepts. Wide area monitoring (WAM) offers many opportunities to enhance the performance of power grid protection. This paper presents a number of these opportunities and therefore the motivation for his or her development. These methods include monitoring the suitability of relay characteristics, supervisory control of backup protection, more adaptive and intelligent system protection and also the creation of novel system integrity protection scheme. The speed of response required for primary protection means the role WAM in enhancing protection is restricted to backup and system protection. The opportunities offered by WAM for enhancing protection are attractive due to the emerging challenges faced by the trendy grid protection. The increasingly variable operating conditions of power systems are making it ever tougher to pick out relay characteristics. This paper presents a quick and robust wide-area backup protection scheme to detect the faulty condition and to spot the faulted line in a very large power network. The proposed methodology uses positive-sequence synchro phasor data captured by either digital relays with synchronization capability or phasor measurement units dispersed over the network. the fundamental idea behind the new protection scheme is that the comparison of bus voltage values calculated through dissimilar paths. Upon occurrence of a fault, the faulty condition is first detected and therefore the bus(es) connected to the faulted line is(are) determined. Among transmission lines connected to the suspected bus(es), the faulted one is thereafter identified. Additionally, to two-terminal transmission lines, multiterminal lines are incorporated. The performance of the proposed method is validated on the IEEE 57-bus test system in numerous fault conditions (fault type, fault location, and fault resistance). Discrimination of faulty and normal conditions is simulated by examining various stressed conditions, for instance, load encroachment, generator outage, and power swing. the info requirement of the proposed technique is analyzed similarly. To do so, a mathematical model for the optimal placement of measurement devices is developed and applied to different IEEE standard test systems.

8. Conclusion

After having a good idea of all the technical parameters and its characteristics we've got designed a rescue and protection system based upon ZigBee technology for wireless communication which may be installed in various factories and mines in order that if anything wrong happens it can alert the control unit. Traditional mine security system is effectively replaced by the surveillance and safety system proposed within the project. a bigger area and more depth inside hazardous underground mines are now will be covered and potential accidents may be controlled effectively. The system combined the low power, low cost, supported high frequency wired data transmission technology. The sensor is preferably installed over the helmets and other gadgets of mine worker.

9. Future scope

A major risk that can cause a large amount of damage in the mine environment is fire. An additional subsystem that could be considered for addition to the mines safety system is fire suppression. This would include the use of a controllable retardant system. While the wireless communication implemented in this design shows success with urban/indoor communication, in order to enhance the system even further, multiple identical node could be introduced. We also look forward to including women safety as an application of this type of system to prevent women from dangerous circumstances.

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